Air Force Research Laboratory|AFRL

Science and Technology for Tomorrow's Air and Space Force

Success Story

AIR FORCE HONORS SENIOR MATERIALS ENGINEER FOR PIONEERING RESEARCH ON FIBER COATINGS

Dr. Randall S. Hay's, of the Materials and Manufacturing Directorate, efforts to understand the complexities of the fiber coating process and eliminate fiber strength degradation on coatings with advanced chemistries have eliminated a key obstacle to the development of these materials for use in severe operational environments. Subsequent work has proceeded rapidly and shows substantial benefits in terms of real composite properties.

Dr. Hay's discovery of the cause of strength degradation has broad implications for the role that corrosion of ceramics plays in nearly all high-temperature systems. Dr. Hay's selection for "Honorable Mention" helps recognize the contributions of men and women serving the nation as members of the AFRL community and enhances the Materials and Manufacturing Directorate's reputation as a world leader in materials research and development.

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Accomplishment

A senior materials research engineer at the directorate recently received an Air Force Basic Research Award "Honorable Mention" for pioneering research supporting the continued development of fiber-reinforced ceramic matrix composites for critical air and space applications. Dr. Hay, of the Metals, Ceramics, and Nondestructive Evaluation Division, identified the mechanisms causing strength degradation of coated fibers (stress corrosion cracking by surface decomposition products of the coating precursors). He and his coworkers then devised a set of experiments to prove these mechanisms existed and found an efficient way to eliminate the problem, while improving high-temperature strength retention.

Background

Fiber-reinforced ceramic matrix composites (CMC) provide significant performance and durability benefits through the combination of temperature capability and mechanical integrity for a diverse range of critical Air Force applications. Examples of these applications include turbine and rocket engine components as well as thermal protection materials on currently fielded, developmental, and future air and space platforms. CMC materials have the potential to operate at temperatures in excess of 2,200º F, well above the operating capabilities of most metals.

Dr. Hay's research concentrates on fiber-matrix interface development, with an emphasis on fiber coating processes, characterization, solid-state reactions, sol-gel thin film development and basic interface science, and on identifying interface chemistries that possess the mechanical behavior and capability to withstand very high temperatures under severe conditions. Working with other members of the directorate's Ceramics Research Group, Dr. Hay led a concentrated research effort on oxidation-resistant, fiber-matrix interfaces.

By solving the fiber corrosion problem, Dr. Hay and his colleagues removed a major barrier to the development of future, revolutionary high-temperature composites for a wide range of Air Force applications. The directorate expects Dr. Hay's improved coating process to apply to other oxide-coating chemistries as well.

Dr. Hay earned undergraduate degrees in chemistry, mechanical engineering, and geomechanics from the University of Rochester, and received his doctoral degree in geophysics from Princeton University. He completed postdoctoral research at the Massachusetts Institute of Technology. Dr. Hay holds several patents related to fiber coating and thin films and has published 55 articles on phase transformations, microstructural development, and fiber coating. He is a 1997 recipient of the directorate's highest scientific honor, the Charles J. Cleary Award, and is an associate editor of the *Journal of the American Ceramic Society*.

Additional information

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Materials and Manufacturing
Awards and Recognition